Center Innovation Fund: MSFC CIF

High Thrust & High ISP Nuclear Thermal Rocket (NTR) Grooved Ring Fuel Element (GRFE)

Completed Technology Project (2012 - 2012)

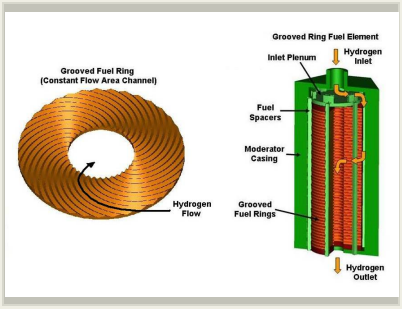
Project Introduction

Missions to Mars will benefit from propulsion systems with performance levels exceeding that of today's best chemical engines. Nuclear Thermal Rocket (NTR) technology has the greatest potential for the near term success of increasing performance, reducing cost, and increasing safety margins by reducing total fuel required, thus reducing total launches for Mars missions. Solid core NTR engines during the Rover/NERVA program demonstrated specific impulses around 850 seconds.

The objective of this innovation effort being proposed for MSFC is to mature an idea with great potential, to analytically verify that the Grooved Ring Fuel Element (GFRE) is thermal- hydraulically stable and confirm that it is able to support high heat transfer rates. These ideas and analyses will quantify the projected performance advantages of the GRFE over the Rover/NERVA and particle bed nuclear fuel elements. Missions to Mars will almost certainly require propulsion systems with performance levels exceeding that of today's best chemical engines. A strong candidate for that propulsion system is the Nuclear Thermal Rocket (NTR). During the 1960's and 1970's the United States embarked on a nuclear rocket program called Rover/NERVA which was quite successful in developing high performance nuclear fuel forms. In spite of this success, however, there surfaced a number of materials and configuration issues which limited the ultimate performance of these engines. In particular, the relatively heavy and difficult to fabricate prismatic fuel block, with its small surface to volume ratio (˜ 5.6 cm-1), caused large core pressure drops which consequently limited the engine thrust to weight ratios to only 3 or 4. To address the problem of low thrust to weight in the Rover/NERVA engine design, a new configuration was proposed called the particle bed reactor where the fuel had a much higher surface to volume ratio (˜ 40 cm-1) and a small pressure drop. This engine was projected to have a thrust to weight ratio of 20 or greater, although the design ultimately proved unsatisfactory because of inherent problems with thermal instabilities resulting from unconstrained propellant flow through the fuel particles. The GFRE is a concept which attempts to combine the best features of the Rover/NERVA fuel element and the particle bed fuel element.

Anticipated Benefits

Project provides long-term, budgetary advantages to NASA. The maturity of this concept development will result in light-weight fuel elements which supports NASA's Strategic Goal #3 by significantly reducing flight costs. It also supports NASA's Strategic Goal #3 by supporting manned missions to Mars and other space flights. It will decrease the time to destination which will decrease the overall resources (food, general supplies, electrical power) needed for flights.



Project Image High Thrust & High ISP Nuclear Thermal Rocket (NTR) Grooved Ring Fuel Element (GRFE)

Table of Contents

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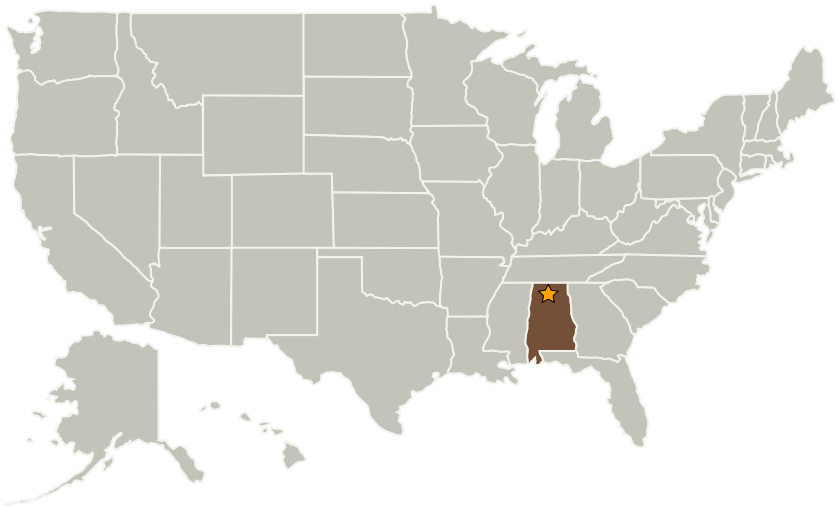
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas
Miltec	Supporting Organization	Industry	

Primary U.S. Work Locations
Alabama

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Center Innovation Fund: MSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

John W Dankanich

Project Manager:

Junghoon Kim

Principal Investigator:

Junghoon Kim

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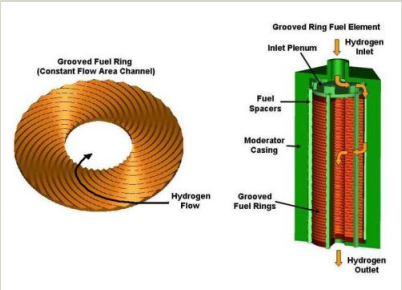
Images



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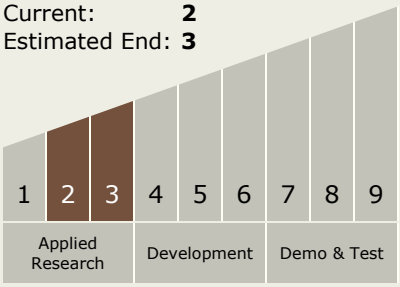
Project Image High Thrust & High ISP Nuclear Thermal Rocket (NTR) Grooved Ring Fuel Element (GRFE) *(https://techport.nasa.gov/image/1332)*

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.3 Nuclear Thermal Propulsion